

CLAIMS

1. A die apparatus for performing a flashless forging operation to manufacture the toothed portion of a steering rack, said die apparatus comprising first and second die members and at least one punch member, each having a forming surface shaped substantially as the obverse of a portion of said toothed portion, and at least a portion of the forming surface of said first die member being shaped substantially as the obverse of the teeth of said rack, **characterised in that** said first and second die members are moveable towards each other to a closed position thereby partially forging said toothed portion from a blank placed in said die apparatus and forming a substantially closed cavity defined by said forming surfaces, said punch member being adapted to move into said cavity, once said die members are in said closed position, thereby completing said forging operation.
- 15 2. A die apparatus as claimed in claim 1 wherein said punch member is moveable into said closed cavity through an aperture in one of said die members.
- 20 3. A die apparatus as claimed in claim 2 wherein said aperture is in said second die member and said punch member is moveable with respect to said second die member.
- 25 4. A die apparatus as claimed in claim 3 wherein said punch member is disposed substantially centrally and opposite said first die member, and is moveable towards said first die member.
5. A die apparatus as claimed in claim 1 wherein said die members abut against each other at said closed position.
- 30 6. A die apparatus as claimed in claim 1 wherein said at least one punch member comprises first and second punch members disposed on opposite sides of said cavity, between said first and second die members.

7. A die apparatus as claimed in claim 1 wherein said punch member is moveable by means of a mechanism operated by the motion of said die apparatus closing.

5 8. A die apparatus as claimed in claim 7 wherein said mechanism comprises at least one wedge member adapted to urge said punch member into said cavity.

9. A die apparatus as claimed in claim 1 wherein at least one of said die members is supported by a hydraulic cylinder pressurised by means of said die apparatus closing.

10 10. A die apparatus as claimed in claim 1 wherein the cross section of said toothed portion is substantially D-shaped.

11. A die apparatus as claimed in claim 1 wherein said blank is a solid bar.

15 12. A die apparatus as claimed in claim 1 wherein said blank is cylindrical.

20 13. A die apparatus as claimed in claim 1 wherein said blank is a hollow bar and said die apparatus further comprises a mandrel adapted to be inserted into said hollow bar prior to said forging operation.

14. A die apparatus as claimed in claim 1 wherein said die apparatus further comprises at least one axially moveable end punch.

25 15. A die apparatus as claimed in claim 14 wherein said end punch is adapted to upset an end of said blank.

16. A method of manufacturing a steering rack comprising performing a forging operation on a blank by means of a die apparatus as claimed in any one of claims
30 1 to 16.

17. A method of manufacturing a steering rack as claimed in claim 16 wherein the teeth of said steering rack are forged to net shape by said forging operation.

18. A method of manufacturing a steering rack as claimed in claim 16 wherein the cross section of the toothed portion of said steering rack is substantially D-shaped.

5 19. A method of manufacturing a steering rack as claimed in claim 16 wherein said blank has a first cylindrical portion and a second cylindrical portion smaller in diameter than said first cylindrical portion, said second cylindrical portion being forged to form the toothed portion of said steering rack, the shaft of said steering rack comprising said first cylindrical portion.

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20. A method of manufacturing a steering rack as claimed in claim 19 wherein said blank further comprises a third cylindrical portion, substantially equal in diameter to said first cylindrical portion, said second cylindrical portion being between said first and third cylindrical portions.

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21. A method of manufacturing a steering rack as claimed in claim 16 wherein said blank is heated to a warm forging temperature prior to said forging operation.

20 22. A die for flashless forging of a steering rack having teeth from a blank, said die comprising at least two die members and at least one punch member, at least one of said die members and said one punch member relatively moveable to converge on said blank when placed in said die, said die members having forming portions substantially the obverse form of said steering rack, said die members defining between them a cavity when said die members converge to a closed position to at least partly forge said steering rack, **characterised in that** said punch member is adapted to perform an inward movement and thereby urge said partly forged blank to substantially fill said cavity.

25 23. A die for flashless forging of a steering rack as claimed in claim 22, wherein said rack is finish forged after said punch member has completed said inward movement.

24. A die for flashless forging of a steering rack as claimed in claim 22, wherein said punch member enters said cavity via a peripheral aperture located in at least one of said die members.
- 5 25. A die for flashless forging of a steering rack as claimed in claim 22, wherein said forged rack has a D-shaped cross section.